

Exercise 8.6

1. Determine the nature of the roots of the following quadratic equations:

Important Notes:

- A quadratic equation is in the form $ax^2 + bx + c = 0$
- To find the nature of roots, first find determinant "D"
- $D = b^2 - 4ac$
- If $D > 0$, equation has real and distinct roots
- If $D < 0$, equation has no real roots
- If $D = 0$, equation has 1 root

(i) $2x^2 - 3x + 5 = 0$

Solution:

Here, $a = 2$, $b = -3$, $c = 5$

$$\begin{aligned} D &= b^2 - 4ac \\ &= (-3)^2 - 4(2)(5) \\ &= 9 - 40 \\ &= -31 < 0 \end{aligned}$$

It's seen that $D < 0$ and hence, the given equation does not have any real roots.

(ii) $2x^2 - 6x + 3 = 0$

Solution:

Here, $a = 2$, $b = -6$, $c = 3$

$$\begin{aligned} D &= (-6)^2 - 4(2)(3) \\ &= 36 - 24 \\ &= 12 > 0 \end{aligned}$$

It's seen that $D > 0$ and hence, the given equation have real and distinct roots.

(iii) $(\frac{3}{5})x^2 - (\frac{2}{3})x + 1 = 0$

Solution:

Here, $a = \frac{3}{5}$, $b = -\frac{2}{3}$, $c = 1$

$$\begin{aligned} D &= (-\frac{2}{3})^2 - 4(\frac{3}{5})(1) \\ &= \frac{4}{9} - \frac{12}{5} \\ &= -\frac{88}{45} < 0 \end{aligned}$$

It's seen that $D < 0$ and hence, the given equation does not have any real roots.

(iv) $3x^2 - 4\sqrt{3}x + 4 = 0$

Solution:

Here, $a = 3$, $b = -4\sqrt{3}$, $c = 4$

$$\begin{aligned} D &= (-4\sqrt{3})^2 - 4(3)(4) \\ &= 48 - 48 \end{aligned}$$

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$$= 0$$

It's seen that $D = 0$ and hence, the given equation has only 1 real and equal root.

(v) $3x^2 - 2\sqrt{6}x + 2 = 0$

Solution:

Here, $a = 3$, $b = -2\sqrt{6}$, $c = 2$

$$D = (-2\sqrt{6})^2 - 4(3)(2)$$

$$= 24 - 24$$

$$= 0$$

It's seen that $D = 0$ and hence, the given equation has only 1 real and equal root.

2. Find the values of k for which the roots are real and equal in each of the following equations:

(i) $kx^2 + 4x + 1 = 0$

Solution:

The given equation $kx^2 + 4x + 1 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = k$, $b = 4$, $c = 1$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow 4^2 - 4(k)(1) = 0$$

$$\Rightarrow 16 - 4k = 0$$

$$\Rightarrow k = 4$$

The value of k is 4.

(ii) $kx^2 - 2\sqrt{5}x + 4 = 0$

Solution:

The given equation $kx^2 - 2\sqrt{5}x + 4 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = k$, $b = -2\sqrt{5}$, $c = 4$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (-2\sqrt{5})^2 - 4(k)(4) = 0$$

$$\Rightarrow 20 - 16k = 0$$

$$\Rightarrow k = 5/4$$

The value of k is 5/4.

(iii) $3x^2 - 5x + 2k = 0$

Solution:

The given equation $3x^2 - 5x + 2k = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 3$, $b = -5$, $c = 2k$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (-5)^2 - 4(3)(2k) = 0$$

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$$\begin{aligned}\Rightarrow 25 - 24k &= 0 \\ \Rightarrow k &= 25/24 \\ \text{The value of } k &\text{ is } 25/24.\end{aligned}$$

(iv) $4x^2 + kx + 9 = 0$

Solution:

The given equation $4x^2 + kx + 9 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 4$, $b = k$, $c = 9$

For the equation to have real and equal roots, the condition is

$$\begin{aligned}D &= b^2 - 4ac = 0 \\ \Rightarrow k^2 - 4(4)(9) &= 0 \\ \Rightarrow k^2 - 144 &= 0 \\ \Rightarrow k &= \pm 12\end{aligned}$$

The value of k is 12 or -12.

(v) $2kx^2 - 40x + 25 = 0$

Solution:

The given equation $2kx^2 - 40x + 25 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 2k$, $b = -40$, $c = 25$

For the equation to have real and equal roots, the condition is

$$\begin{aligned}D &= b^2 - 4ac = 0 \\ \Rightarrow (-40)^2 - 4(2k)(25) &= 0 \\ \Rightarrow 1600 - 200k &= 0 \\ \Rightarrow k &= 8\end{aligned}$$

The value of k is 8.

(vi) $9x^2 - 24x + k = 0$

Solution:

The given equation $9x^2 - 24x + k = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 9$, $b = -24$, $c = k$

For the equation to have real and equal roots, the condition is

$$\begin{aligned}D &= b^2 - 4ac = 0 \\ \Rightarrow (-24)^2 - 4(9)(k) &= 0 \\ \Rightarrow 576 - 36k &= 0 \\ \Rightarrow k &= 16\end{aligned}$$

The value of k is 16.

(vii) $4x^2 - 3kx + 1 = 0$

Solution:

The given equation $4x^2 - 3kx + 1 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 4$, $b = -3k$, $c = 1$

For the equation to have real and equal roots, the condition is

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$$\begin{aligned} D &= b^2 - 4ac = 0 \\ \Rightarrow & (-3k)^2 - 4(4)(1) = 0 \\ \Rightarrow & 9k^2 - 16 = 0 \\ \Rightarrow & k = \pm 4/3 \end{aligned}$$

The value of k is $\pm 4/3$.

(viii) $x^2 - 2(5 + 2k)x + 3(7 + 10k) = 0$

Solution:

The given equation $x^2 - 2(5 + 2k)x + 3(7 + 10k) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 1$, $b = -2(5 + 2k)$, $c = 3(7 + 10k)$

For the equation to have real and equal roots, the condition is

$$\begin{aligned} D &= b^2 - 4ac = 0 \\ \Rightarrow & (-2(5 + 2k))^2 - 4(1)(3(7 + 10k)) = 0 \\ \Rightarrow & 4(5 + 2k)^2 - 12(7 + 10k) = 0 \\ \Rightarrow & 25 + 4k^2 + 20k - 21 - 30k = 0 \\ \Rightarrow & 4k^2 - 10k + 4 = 0 \\ \Rightarrow & 2k^2 - 5k + 2 = 0 \quad [\text{dividing by 2}] \end{aligned}$$

Now, solving for k by factorization we have

$$\begin{aligned} \Rightarrow & 2k^2 - 4k - k + 2 = 0 \\ \Rightarrow & 2k(k - 2) - 1(k - 2) = 0 \\ \Rightarrow & (k - 2)(2k - 1) = 0, \end{aligned}$$

$k = 2$ and $k = 1/2$,

So, the value of k can either be 2 or 1/2

(ix) $(3k + 1)x^2 + 2(k + 1)x + k = 0$

Solution:

The given equation $(3k + 1)x^2 + 2(k + 1)x + k = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (3k + 1)$, $b = 2(k + 1)$, $c = k$

For the equation to have real and equal roots, the condition is

$$\begin{aligned} D &= b^2 - 4ac = 0 \\ \Rightarrow & (2(k + 1))^2 - 4(3k + 1)(k) = 0 \\ \Rightarrow & 4(k + 1)^2 - 4(3k^2 + k) = 0 \\ \Rightarrow & (k + 1)^2 - k(3k + 1) = 0 \\ \Rightarrow & 2k^2 - k - 1 = 0 \end{aligned}$$

Now, solving for k by factorization we have

$$\begin{aligned} \Rightarrow & 2k^2 - 2k + k - 1 = 0 \\ \Rightarrow & 2k(k - 1) + 1(k - 1) = 0 \\ \Rightarrow & (k - 1)(2k + 1) = 0, \end{aligned}$$

$k = 1$ and $k = -1/2$,

So, the value of k can either be 1 or -1/2

(x) $kx^2 + kx + 1 = -4x^2 - x$

Solution:

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The given equation $kx^2 + kx + 1 = -4x^2 - x$

This can be rewritten as,

$$(k + 4)x^2 + (k + 1)x + 1 = 0$$

Now, this in the form of $ax^2 + bx + c = 0$

Where $a = (k + 4)$, $b = (k + 1)$, $c = 1$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (k + 1)^2 - 4(k + 4)(1) = 0$$

$$\Rightarrow (k + 1)^2 - 4k - 16 = 0$$

$$\Rightarrow k^2 + 2k + 1 - 4k - 16 = 0$$

$$\Rightarrow k^2 - 2k - 15 = 0$$

Now, solving for k by factorization we have

$$\Rightarrow k^2 - 5k + 3k - 15 = 0$$

$$\Rightarrow k(k - 5) + 3(k - 5) = 0$$

$$\Rightarrow (k + 3)(k - 5) = 0,$$

$$k = -3 \text{ and } k = 5,$$

So, the value of k can either be -3 or 5 .

(xi) $(k + 1)x^2 + 2(k + 3)x + (k + 8) = 0$

Solution:

The given equation $(k + 1)x^2 + 2(k + 3)x + (k + 8) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (k + 1)$, $b = 2(k + 3)$, $c = (k + 8)$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (2(k + 3))^2 - 4(k + 1)(k + 8) = 0$$

$$\Rightarrow 4(k + 3)^2 - 4(k^2 + 9k + 8) = 0$$

$$\Rightarrow (k + 3)^2 - (k^2 + 9k + 8) = 0$$

$$\Rightarrow k^2 + 6k + 9 - k^2 - 9k - 8 = 0$$

$$\Rightarrow -3k + 1 = 0$$

$$\Rightarrow k = 1/3$$

So, the value of k is $1/3$.

(xii) $x^2 - 2kx + 7k - 12 = 0$

Solution:

The given equation $x^2 - 2kx + 7k - 12 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 1$, $b = -2k$, $c = 7k - 12$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (-2k)^2 - 4(1)(7k - 12) = 0$$

$$\Rightarrow 4k^2 - 4(7k - 12) = 0$$

$$\Rightarrow k^2 - 7k + 12 = 0$$

Now, solving for k by factorization we have

$$\Rightarrow k^2 - 4k - 3k + 12 = 0$$

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$\Rightarrow (k - 4)(k - 3) = 0,$
 $k = 4$ and $k = 3,$
So, the value of k can either be 4 or 3.

(xiii) $(k + 1)x^2 - 2(3k + 1)x + 8k + 1 = 0$

Solution:

The given equation $(k + 1)x^2 - 2(3k + 1)x + 8k + 1 = 0$ is in the form of $ax^2 + bx + c = 0$
Where $a = (k + 1), b = -2(3k + 1), c = 8k + 1$

For the equation to have real and equal roots, the condition is

$$\begin{aligned} D &= b^2 - 4ac = 0 \\ \Rightarrow &(-2(3k + 1))^2 - 4(k + 1)(8k + 1) = 0 \\ \Rightarrow &4(3k + 1)^2 - 4(k + 1)(8k + 1) = 0 \\ \Rightarrow &(3k + 1)^2 - (k + 1)(8k + 1) = 0 \\ \Rightarrow &9k^2 + 6k + 1 - (8k^2 + 9k + 1) = 0 \\ \Rightarrow &9k^2 + 6k + 1 - 8k^2 - 9k - 1 = 0 \\ \Rightarrow &k^2 - 3k = 0 \\ \Rightarrow &k(k - 3) = 0 \end{aligned}$$

Either $k = 0$ Or, $k - 3 = 0 \Rightarrow k = 3,$
So, the value of k can either be 0 or 3

(xiv) $5x^2 - 4x + 2 + k(4x^2 - 2x + 1) = 0$

Solution:

The given equation $5x^2 - 4x + 2 + k(4x^2 - 2x + 1) = 0$

This can be rewritten as,

$$x^2(5 + 4k) - x(4 + 2k) + 2 - k = 0$$

Now, this in the form of $ax^2 + bx + c = 0$

Where $a = (4k + 5), b = -(2k + 4), c = 2 - k$

For the equation to have real and equal roots, the condition is

$$\begin{aligned} D &= b^2 - 4ac = 0 \\ \Rightarrow &(-(2k + 4))^2 - 4(4k + 5)(2 - k) = 0 \\ \Rightarrow &(2k + 4)^2 - 4(4k + 5)(2 - k) = 0 \\ \Rightarrow &16 + 4k^2 + 16k - 4(10 - 5k + 8k - 4k^2) = 0 \\ \Rightarrow &16 + 4k^2 + 16k - 40 + 20k - 32k + 16k^2 = 0 \\ \Rightarrow &20k^2 + 4k - 24 = 0 \\ \Rightarrow &5k^2 + k - 6 = 0 \end{aligned}$$

Now, solving for k by factorization we have

$$\begin{aligned} \Rightarrow &5k^2 + 6k - 5k - 6 = 0 \\ \Rightarrow &5k(k - 1) + 6(k - 1) = 0 \\ \Rightarrow &(k - 1)(5k + 6) = 0, \end{aligned}$$

$k = 1$ and $k = -6/5,$

So, the value of k can either be 1 or $-6/5.$

(xv) $(4 - k)x^2 + (2k + 4)x + (8k + 1) = 0$

Solution:

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The given equation $(4 - k)x^2 + (2k + 4)x + (8k + 1) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (4 - k)$, $b = (2k + 4)$, $c = (8k + 1)$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (2k + 4)^2 - 4(4 - k)(8k + 1) = 0$$

$$\Rightarrow 4k^2 + 16k + 16 - 4(-8k^2 + 32k + 4 - k) = 0$$

$$\Rightarrow 4k^2 + 16k + 16 + 32k^2 - 124k - 16 = 0$$

$$\Rightarrow 36k^2 - 108k = 0$$

Taking common,

$$\Rightarrow 9k(k - 3) = 0$$

Now, either $9k = 0 \Rightarrow k = 0$ or $k - 3 = 0 \Rightarrow k = 3$,

So, the value of k can either be 0 or 3.

(xvi) $(2k + 1)x^2 + 2(k + 3)x + (k + 5) = 0$

Solution:

The given equation $(2k + 1)x^2 + 2(k + 3)x + (k + 5) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (2k + 1)$, $b = 2(k + 3)$, $c = (k + 5)$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (2(k + 3))^2 - 4(2k + 1)(k + 5) = 0$$

$$\Rightarrow 4(k + 3)^2 - 4(2k^2 + 11k + 5) = 0$$

$$\Rightarrow (k + 3)^2 - (2k^2 + 11k + 5) = 0 \text{ [dividing by 4 both sides]}$$

$$\Rightarrow k^2 + 5k - 4 = 0$$

Now, solving for k by completing the square we have

$$\Rightarrow k^2 + 2 \times (5/2) \times k + (5/2)^2 = 4 + (5/2)^2$$

$$\Rightarrow (k + 5/2)^2 = 4 + 25/4 = \sqrt{41/4}$$

$$\Rightarrow k + (5/2) = \pm \sqrt{41/2}$$

$$\Rightarrow k = (\sqrt{41} - 5)/2 \text{ or } -(\sqrt{41} + 5)/2$$

So, the value of k can either be $(\sqrt{41} - 5)/2$ or $-(\sqrt{41} + 5)/2$

(xvii) $4x^2 - 2(k + 1)x + (k + 4) = 0$

Solution:

The given equation $4x^2 - 2(k + 1)x + (k + 4) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 4$, $b = -2(k + 1)$, $c = (k + 4)$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (-2(k + 1))^2 - 4(4)(k + 4) = 0$$

$$\Rightarrow 4(k + 1)^2 - 16(k + 4) = 0$$

$$\Rightarrow (k + 1)^2 - 4(k + 4) = 0$$

$$\Rightarrow k^2 - 2k - 15 = 0$$

Now, solving for k by factorization we have

$$\Rightarrow k^2 - 5k + 3k - 15 = 0$$

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$$\begin{aligned}\Rightarrow k(k - 5) + 3(k - 5) &= 0 \\ \Rightarrow (k - 5)(k + 3) &= 0, \\ k = 5 \text{ and } k = -3, \\ \text{So, the value of } k &\text{ can either be } 5 \text{ or } -3.\end{aligned}$$

3. In the following, determine the set of values of k for which the given quadratic equation has real roots:

(i) $2x^2 + 3x + k = 0$

Solution:

Given,
 $2x^2 + 3x + k = 0$
It's of the form of $ax^2 + bx + c = 0$
Where, $a = 2, b = 3, c = k$
For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$
 $D = 9 - 4(2)(k) \geq 0$
 $\Rightarrow 9 - 8k \geq 0$
 $\Rightarrow k \leq 9/8$
The value of k should not exceed 9/8 to have real roots.

(ii) $2x^2 + x + k = 0$

Solution:

Given,
 $2x^2 + x + k = 0$
It's of the form of $ax^2 + bx + c = 0$
Where, $a = 2, b = 1, c = k$
For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$
 $D = 1^2 - 4(2)(k) \geq 0$
 $\Rightarrow 1 - 8k \geq 0$
 $\Rightarrow k \leq 1/8$
The value of k should not exceed 1/8 to have real roots.

(iii) $2x^2 - 5x - k = 0$

Solution:

Given,
 $2x^2 - 5x - k = 0$
It's of the form of $ax^2 + bx + c = 0$
Where, $a = 2, b = -5, c = -k$
For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$
 $D = (-5)^2 - 4(2)(-k) \geq 0$
 $\Rightarrow 25 + 8k \geq 0$
 $\Rightarrow k \geq -25/8$
The value of k should be lesser than -25/8 to have real roots.

(iv) $kx^2 + 6x + 1 = 0$

Solution:

Given,

$$kx^2 + 6x + 1 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = 6$, $c = 1$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = 6^2 - 4(k)(1) \geq 0$$

$$\Rightarrow 36 - 4k \geq 0$$

The given equation will have real roots if,

$$\Rightarrow 36 \geq 4k$$

$$\Rightarrow 36/4 \geq k$$

$$\Rightarrow 9 \geq k$$

$$\Rightarrow k \leq 9$$

The value of k should not exceed 9 to have real roots.

(v) $3x^2 + 2x + k = 0$

Solution:

Given,

$$3x^2 + 2x + k = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 3$, $b = 2$, $c = k$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (2)^2 - 4(3)(k) \geq 0$$

$$\Rightarrow 4 - 12k \geq 0$$

$$\Rightarrow 4 \geq 12k$$

$$\Rightarrow k \leq 1/3$$

The value of k should not exceed $1/3$ to have real roots.

4. Find the values of k for which the following equations have real and equal roots

(i) $x^2 - 2(k + 1)x + k^2 = 0$

Solution:

Given,

$$x^2 - 2(k + 1)x + k^2 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 1$, $b = -2(k + 1)$, $c = k^2$

For the given quadratic equation to have real roots $D = b^2 - 4ac = 0$

$$D = (-2(k + 1))^2 - 4(1)(k^2) = 0$$

$$\Rightarrow 4k^2 + 8k + 4 - 4k^2 = 0$$

$$\Rightarrow 8k + 4 = 0$$

$$\Rightarrow k = -4/8$$

$$\Rightarrow k = -1/2$$

The value of k should $-1/2$ to have real and equal roots.

(ii) $k^2x^2 - 2(2k - 1)x + 4 = 0$

Solution:

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Given,

$$k^2x^2 - 2(2k - 1)x + 4 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k^2$, $b = -2(2k - 1)$, $c = 4$

For the given quadratic equation to have real roots $D = b^2 - 4ac = 0$

$$D = (-2(2k - 1))^2 - 4(4)(k^2) = 0$$

$$\Rightarrow 4k^2 - 4k + 1 - 4k^2 = 0 \quad [\text{dividing by 4 both sides}]$$

$$\Rightarrow -4k + 1 = 0$$

$$\Rightarrow k = 1/4$$

The value of k should be $1/4$ to have real and equal roots.

(iii) $(k + 1)x^2 - 2(k - 1)x + 1 = 0$

Solution:

Given,

$$(k + 1)x^2 - 2(k - 1)x + 1 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = (k + 1)$, $b = -2(k - 1)$, $c = 1$

For the given quadratic equation to have real roots $D = b^2 - 4ac = 0$

$$D = (-2(k - 1))^2 - 4(1)(k + 1) = 0$$

$$\Rightarrow 4k^2 - 2k + 1 - k - 1 = 0 \quad [\text{dividing by 4 both sides}]$$

$$\Rightarrow k^2 - 3k = 0$$

$$\Rightarrow k(k - 3) = 0$$

$$\Rightarrow k = 0 \text{ or } k = 3$$

The value of k can be 0 or 3 to have real and equal roots.

5. Find the values of k for which the following equations have real roots

(i) $2x^2 + kx + 3 = 0$

Solution:

Given,

$$2x^2 + kx + 3 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 2$, $b = k$, $c = 3$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (k)^2 - 4(3)(2) \geq 0$$

$$\Rightarrow k^2 - 24 \geq 0$$

$$\Rightarrow k^2 \geq 24$$

$$\Rightarrow k \geq 2\sqrt{6} \text{ and } k \leq -2\sqrt{6} \quad [\text{After taking square root on both sides}]$$

The value of k can be represented as $(\infty, 2\sqrt{6}] \cup [-2\sqrt{6}, -\infty)$

(ii) $kx(x - 2) + 6 = 0$

Solution:

Given,

$$kx(x - 2) + 6 = 0$$

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It can be rewritten as,

$$kx^2 - 2kx + 6 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = -2k$, $c = 6$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (-2k)^2 - 4(k)(6) \geq 0$$

$$\Rightarrow 4k^2 - 24k \geq 0$$

$$\Rightarrow 4k(k - 6) \geq 0$$

$$\Rightarrow k \geq 0 \text{ and } k \geq 6$$

$$\Rightarrow k \geq 6$$

The value of k should be greater than or equal to 6 to have real roots.

(iii) $x^2 - 4kx + k = 0$

Solution:

Given,

$$x^2 - 4kx + k = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 1$, $b = -4k$, $c = k$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (-4k)^2 - 4(1)(k) \geq 0$$

$$\Rightarrow 16k^2 - 4k \geq 0$$

$$\Rightarrow 4k(4k - 1) \geq 0$$

$$\Rightarrow k \geq 0 \text{ and } k \geq 1/4$$

$$\Rightarrow k \geq 1/4$$

The value of k should be greater than or equal to $1/4$ to have real roots.

(iv) $kx(x - 2\sqrt{5}) + 10 = 0$

Solution:

Given,

$$kx(x - 2\sqrt{5}) + 10 = 0$$

It can be rewritten as,

$$kx^2 - 2\sqrt{5}kx + 10 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = -2\sqrt{5}k$, $c = 10$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (-2\sqrt{5}k)^2 - 4(k)(10) \geq 0$$

$$\Rightarrow 20k^2 - 40k \geq 0$$

$$\Rightarrow 20k(k - 2) \geq 0$$

$$\Rightarrow k \geq 0 \text{ and } k \geq 2$$

$$\Rightarrow k \geq 2$$

The value of k should be greater than or equal to 2 to have real roots.

(v) $kx(x - 3) + 9 = 0$

Solution:

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Given,

$$kx(x - 3) + 9 = 0$$

It can be rewritten as,

$$kx^2 - 3kx + 9 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = -3k$, $c = 9$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (-3k)^2 - 4(k)(9) \geq 0$$

$$\Rightarrow 9k^2 - 36k \geq 0$$

$$\Rightarrow 9k(k - 4) \geq 0$$

$$\Rightarrow k \geq 0 \text{ and } k \geq 4$$

$$\Rightarrow k \geq 4$$

The value of k should be greater than or equal to 4 to have real roots.

(vi) $4x^2 + kx + 3 = 0$

Solution:

Given,

$$4x^2 + kx + 3 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 4$, $b = k$, $c = 3$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (k)^2 - 4(4)(3) \geq 0$$

$$\Rightarrow k^2 - 48 \geq 0$$

$$\Rightarrow k^2 \geq 48$$

$$\Rightarrow k \geq 4\sqrt{3} \text{ and } k \leq -4\sqrt{3} \quad [\text{After taking square root on both sides}]$$

The value of k can be represented as $(\infty, 4\sqrt{3}] \cup [-4\sqrt{3}, -\infty)$

6. Find the values of k for which the given quadratic equation has real and distinct roots.

(i) $kx^2 + 2x + 1 = 0$

Solution:

Given,

$$kx^2 + 2x + 1 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = 2$, $c = 1$

For the given quadratic equation to have real roots $D = b^2 - 4ac > 0$

$$D = (2)^2 - 4(1)(k) > 0$$

$$\Rightarrow 4 - 4k > 0$$

$$\Rightarrow 4k < 4$$

$$\Rightarrow k < 1$$

The value of k should be lesser than 1 to have real and distinct roots.

(ii) $kx^2 + 6x + 1 = 0$

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Solution:

Given,

$$kx^2 + 6x + 1 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = k$, $b = 6$, $c = 1$

For the given quadratic equation to have real roots $D = b^2 - 4ac > 0$

$$D = (6)^2 - 4(1)(k) > 0$$

$$\Rightarrow 36 - 4k > 0$$

$$\Rightarrow 4k < 36$$

$$\Rightarrow k < 9$$

The value of k should be lesser than 9 to have real and distinct roots.

7. For what value of k , $(4 - k)x^2 + (2k + 4)x + (8k + 1) = 0$, is a perfect square.

Solution:

Given,

$$(4 - k)x^2 + (2k + 4)x + (8k + 1) = 0$$

It is in the form of $ax^2 + bx + c = 0$

Where, $a = 4 - k$, $b = 2k + 4$, $c = 8k + 1$

Calculating the discriminant, $D = b^2 - 4ac$

$$= (2k + 4)^2 - 4(4 - k)(8k + 1)$$

$$= 4k^2 + 16 + 4k - 4(32 + 4 - 8k^2 - k)$$

$$= 4(k^2 + 4 + k - 32 - 4 + 8k^2 + k)$$

$$= 4(9k^2 - 27k)$$

As the given equation is a perfect square, then $D = 0$

$$\Rightarrow 4(9k^2 - 27k) = 0$$

$$\Rightarrow (9k^2 - 27k) = 0$$

$$\Rightarrow 3k(k - 3) = 0$$

Thus, $3k = 0 \Rightarrow k = 0$ Or, $k - 3 = 0 \Rightarrow k = 3$

Hence, the value of k should be 0 or 3 for the given to be perfect square.

8. Find the least positive value of k for which the equation $x^2 + kx + 4 = 0$ has real roots.

Solution:

Given,

$$x^2 + kx + 4 = 0$$

It's of the form of $ax^2 + bx + c = 0$

Where, $a = 1$, $b = k$, $c = 4$

For the given quadratic equation to have real roots $D = b^2 - 4ac \geq 0$

$$D = (k)^2 - 4(1)(4) \geq 0$$

$$\Rightarrow k^2 - 16 \geq 0$$

$$\Rightarrow k \geq 4 \text{ and } k \leq -4$$

Considering the least positive value, we have

$$\Rightarrow k = 4$$

Thus, the least value of k is 4 for the given equation to have real roots.

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9. Find the values of k for which the quadratic equation $(3k + 1)x^2 + 2(k + 1)x + 1 = 0$ has equal roots. Also, find the roots.

Solution:

The given equation $(3k + 1)x^2 + 2(k + 1)x + 1 = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (3k + 1)$, $b = 2(k + 1)$, $c = 1$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (2(k + 1))^2 - 4(3k + 1)(1) = 0$$

$$\Rightarrow (k + 1)^2 - (3k + 1) = 0 \quad \text{[After dividing by 4 both sides]}$$

$$\Rightarrow k^2 + 2k + 1 - 3k - 1 = 0$$

$$\Rightarrow k^2 - k = 0$$

$$\Rightarrow k(k - 1) = 0$$

Either $k = 0$ Or, $k - 1 = 0 \Rightarrow k = 1$,

So, the value of k can either be 0 or 1

Now, using $k = 0$ in the given quadratic equation we get

$$(3(0) + 1)x^2 + 2(0 + 1)x + 1 = 0$$

$$x^2 + 2x + 1 = 0$$

$$\Rightarrow (x + 1)^2 = 0$$

Thus, $x = -1$ is the root of the given quadratic equation.

Next, on using $k = 1$ in the given quadratic equation we get

$$(3(1) + 1)x^2 + 2(1 + 1)x + 1 = 0$$

$$4x^2 + 4x + 1 = 0$$

$$\Rightarrow (2x + 1)^2 = 0$$

Thus, $2x = -1 \Rightarrow x = -1/2$ is the root of the given quadratic equation.

10. Find the values of p for which the quadratic equation $(2p + 1)x^2 - (7p + 2)x + (7p - 3) = 0$ has equal roots. Also, find the roots.

Solution:

The given equation $(2p + 1)x^2 - (7p + 2)x + (7p - 3) = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = (2p + 1)$, $b = -(7p + 2)$, $c = (7p - 3)$

For the equation to have real and equal roots, the condition is

$$D = b^2 - 4ac = 0$$

$$\Rightarrow (-(7p + 2))^2 - 4(2p + 1)(7p - 3) = 0$$

$$\Rightarrow (7p + 2)^2 - 4(14p^2 + p - 3) = 0$$

$$\Rightarrow 49p^2 + 28p + 4 - 56p^2 - 4p + 12 = 0$$

$$\Rightarrow -7p^2 + 24p + 16 = 0$$

Solving for p by factorization,

$$\Rightarrow -7p^2 + 28p - 4p + 16 = 0$$

$$\Rightarrow -7p(p - 4) - 4(p - 4) = 0$$

$$\Rightarrow (p - 4)(-7p - 4) = 0$$

Either $p - 4 = 0 \Rightarrow p = 4$ Or, $7p + 4 = 0 \Rightarrow p = -4/7$,

So, the value of k can either be 4 or $-4/7$

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Now, using $k = 4$ in the given quadratic equation we get

$$(2(4) + 1)x^2 - (7(4) + 2)x + (7(4) - 3) = 0$$

$$9x^2 - 30x + 25 = 0$$

$$\Rightarrow (3x - 5)^2 = 0$$

Thus, $x = 5/3$ is the root of the given quadratic equation.

Next, on using $k = 1$ in the given quadratic equation we get

$$(2(-4/7) + 1)x^2 - (7(-4/7) + 2)x + (7(-4/7) - 3) = 0$$

$$x^2 - 14x + 49 = 0$$

$$\Rightarrow (x - 7)^2 = 0$$

Thus, $x - 7 = 0 \Rightarrow x = 7$ is the root of the given quadratic equation.

11. If -5 is a root of the quadratic equation $2x^2 + px - 15 = 0$ and the quadratic equation $p(x^2 + x) + k = 0$ has equal roots, find the value of k .

Solution:

Given,

-5 is as root of $2x^2 + px - 15 = 0$

So, on substituting $x = -5$ the LHS will become zero and satisfy the equation.

$$\Rightarrow 2(-5)^2 + p(-5) - 15 = 0$$

$$\Rightarrow 50 - 5p - 15 = 0$$

$$\Rightarrow 35 = 5p$$

$$\Rightarrow p = 7$$

Now, substituting the value of p in the second equation we have

$$(7)(x^2 + x) + k = 0$$

$$\Rightarrow 7x^2 + 7x + k = 0$$

It's given that the above equation has equal roots.

Thus the discriminant, $D = 0$

The equation $7x^2 + 7x + k = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 7$, $b = 7$, $c = k$

$$D = b^2 - 4ac$$

$$\Rightarrow 7^2 - 4(7)(k) = 0$$

$$\Rightarrow 49 - 28k = 0$$

$$\Rightarrow k = 49/28 = 7/4$$

Therefore, the value of k is $7/4$.

12. If 2 is a root of the quadratic equation $3x^2 + px - 8 = 0$ and the quadratic equation $4x^2 - 2px + k = 0$ has equal roots, find the value of k .

Solution:

Given,

2 is as root of $3x^2 + px - 8 = 0$

So, on substituting $x = 2$ the LHS will become zero and satisfy the equation.

$$\Rightarrow 3(2)^2 + p(2) - 8 = 0$$

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$$\Rightarrow 12 + 2p - 8 = 0$$

$$\Rightarrow 4 + 2p = 0$$

$$\Rightarrow p = -2$$

Now, substituting the value of p in the second equation we have

$$4x^2 - 2(-2)x + k = 0$$

$$\Rightarrow 4x^2 + 4x + k = 0$$

It's given that the above equation has equal roots.

Thus the discriminant, $D = 0$

The equation $4x^2 + 4x + k = 0$ is in the form of $ax^2 + bx + c = 0$

Where $a = 4$, $b = 4$, $c = k$

$$D = b^2 - 4ac$$

$$\Rightarrow 4^2 - 4(4)(k) = 0$$

$$\Rightarrow 16 - 16k = 0 \quad [\text{dividing by 16 both sides}]$$

$$\Rightarrow k = 1$$

Therefore, the value of k is 1.



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